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Prevention of extravasation in intravenous therapy: a review of the research evidence

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Abstract

Intravenous therapy is now considered to be completely routine for nurses as they are involved in many of its aspects including managing intravenous cannulation and drug administration, and peripherally inserted central lines (Rogers 1997:546). As nurses have a growing responsibility in intravenous therapy and its management it is important that they anticipate the associated health risks, particularly those associated with peripheral intravenous cannulation devices (Fuller 1998:675). One potential problem associated with intravenous therapy, and perhaps the most frequent complication, is that of extravasation (Clarke 1997: 202; Jackson 1997: 22; Weinstein 1997: 524; Bohony 1993: 45; Springhouse Corporation 1993:132; Wood and Gullo 1993: 46).

Extravasation is the accidental leakage of drugs or infusion fluid into the perivascular or subcutaneous tissue (Navarro 1998: 38; Clarke 1997: 202; Springhouse Corporation 1993: 132). Extravasation of vesicant drugs or fluids commonly results in severe local tissue damage which may cause prolonged healing, infection, tissue necrosis, multiple debridements, cosmetic disfigurement, nerve damage, loss of function of an extremity, and possibly amputation (Brown et al 1979; Upton et al 1979; both cited in Pettit and Hughes 1993: 70; Springhouse Corporation 1993: 281). Clearly extravasation is an inherent danger of intravenous therapy and as such early detection in conjunction with prompt treatment will significantly reduce the complications following intravenous extravasation (Weinstein 1997: 518; Pettit and Hughes 1993: 73). More importantly, nurses must have knowledge of ways in which to prevent IV-related problems such as extravasation as prevention is the key to decreasing such complications (Pettit and Hughes 1993: 77). This essay will discuss intravenous extravasation, in particular its prevention and treatment with regard to new developments and improvements in nursing care found in the research literature.

While extravasation has been reported with a number of access devices, it is most common with venous access ports (LaRocca 1994:115). LaRocca notes that accidental needle dislodgement was the most common cause of extravasation (1994:115). Pettit and Hughes argue that while venous puncture may occur on occasion, particularly when sharp needles are used, other explanations for extravasation have been proposed (1993: 70).

One explanation involves an association with irritation of the venous endothelium and vessel wall, causing vasoconstriction and diminished blood flow within the vein, ultimately increasing pressure and leading to rupture of the vein, thus allowing fluid to extravate into surrounding tissues (Clarke 1997: 202; Hecker 1988 cited in Pettit and Hughes 1993: 70). Another mechanism of injury involves the infusate extravating through the insertion hole that was made at the entrance to the

vein, while the cannula tip remains within the lumen of the blood vessel (Hecker 1992 cited in Pettit and Hughes 1993: 70). This will only occur if the flow proximal to the cannula tip is obstructed and the valves distal to the tip must be closed so that a high intra-luminal pressure develops in the vicinity of the cannula tip, expanding the hole in the venous wall and allowing fluid to extravate into perivenous tissues (Lewis and Hecker 1991; Hecker 1984 both cited in Pettit and Hughes 1993: 70).

Pettit and Hughes acknowledge that a variety of pharmacologic agents including solutions and electrolytes, antibiotics, vasopressors, and chemotherapeutic agents have been shown to cause or contribute to IV extravasation injuries (1993: 70). Solutions and electrolyte complications include a local sclerosing effect, leakage of the vein and/or tissue necrosis (Collinge and Aranda 1984 cited in Pettit and Hughes 1993: 71). Antibiotics have been implicated in the increased incidence of extravasation and the potential for severe local reactions and necrosis in both infants and adults in a number of reports (Brown et al 1979; Upton et al 1979 both cited in Pettit and Hughes 1993: 72). Extravasation of vasopressors such as adrenaline, noradrenaline and dopamine have been shown to cause tissue necrosis due to intense vasoconstriction of the smooth muscle of capillaries, resulting in ischaemia (Pettit and Hughes 1993: 71).

Chemotherapeutic agents are the most toxic of intravenous pharmacologic agents (Del Guido and Menonna-Quinn 1998: 59; Pettit and Hughes 1993: 72). All antineoplastics have the ability to cause severe and widespread tissue necrosis if extravasated during administration due to their cytotoxic effect (Pettit and Hughes 1993: 73; Wood and Gullo 1993: 42). Consequently these antineoplastic drugs, in addition to those previously mentioned, are known as vesicants. That is, they have the ability to cause cellular damage or destruction or tissue necrosis upon leakage into the subcutaneous tissue as a result of extravasation (Navarro 1998: 38; Clarke 1997: 202; LaRocca 1994:114). Damage will be greater if the extravasation occurs over areas with little subcutaneous tissue or over nerves, tendons, or joint spaces (LaRocca 1994: 114).

Pettit and Hughes assert that recognition of extravasation can be difficult and as a consequence it is frequently underestimated (1993: 69, 70). Compounding this is that extravasation can occur without perceptible symptoms (Weinstein 1997: 518). Despite this possibility, it has been argued that coolness is the best indicator of extravasation as it almost always occurs and can be easily palpated (Bohony 1993: 45). Other common symptoms and signs include pain (Clarke 1997: 202; Dougherty 1997: 41; Weinstein 1997: 518; LaRocca 1994:114), stinging at site of extravasation (Navarro 1998: 38; Weinstein 1997: 518; LaRocca 1994:114), burning sensation at IV site (Del Guido and Menonna-Quinn 1998: 59; Navarro 1998: 38; Clarke 1997: 202; Weinstein 1997: 518; LaRocca 1994:114; Wood and Gullo 1993: 42), and swelling (Del Guido and Menonna-Quinn 1998: 59; Clarke 1997: 202; Dougherty 1997: 41; Pettit and Hughes 1993: 69; Springhouse Corporation 1993:136; Wood and Gullo 1993: 42). Possible signs and symptoms include blanching of the skin (Clarke 1997: 202; Springhouse Corporation 1993:136), erythema (Del Guido and Menonna-Quinn 1998: 59; Navarro 1998: 38) and limited movement (Clarke 1997: 202).

If extravasation has occurred, prompt treatment must be undertaken to minimise complications. Weinstein cites that if vesicant extravasation is suspected it should be treated as a presumed extravasation (1997: 525). LaRocca asserts that treatment of extravasation is controversial (1994:114). This may be due to the small number of clinical studies documenting the efficacy of treatment (Pettit and Hughes 1993: 73). Clearly allowing the extravasation of known vesicants as a

test to determine effective treatment therapies would be unethical, and as such nurses and other health care providers have been forced to rely upon those treatments found effective in clinical care reports in humans and in (cruel) animal studies (Pettit and Hughes 1993: 73).

Upon recognition of extravasation the infusion must be stopped immediately to prevent further leakage into subcutaneous tissues (Navarro 1998: 38; Clarke 1997: 202; Weinstein 1997: 525; Lakocca 1994: 114). An attempt must be made to aspirate back the remaining drug in the needle and tubing to remove any residual drug (Navarro 1998: 38; Weinstein 1997: 527). Weinstein also suggests superimposing normal saline to dilute the extravated agent (1997: 527). If a vesicant has extravated, its specific antidote must be administered by IV push to intentionally extravate it via the same route as the extravated vesicant, thus decreasing the risk of tissue necrosis (Weinstein 1997: 527; Zenk 1980 cited in Pettit and Hughes 1993: 73). The needle must be removed, followed by the administration of antidotes with multiple punctures into the suspected extravasation site (Weinstein 1997: 527). For example, hyaluronidase is used in the extravasation of solutions and electrolytes such as dextrose 10% and greater, parenteral nutrition, and calcium and potassium solutions; antibiotics such as gentamicin and ampicillin (Pettit and Hughes 1993: 74); and chemotherapeutic agents such as vincristine and teniposide (Weinstein 1997: 524). The antidote phentolamine is administered when vasopressors such as dopamine and noradrenaline extravate into subcutaneous tissues (Pettit and Hughes 1993: 74). The affected extremity must be elevated to promote venous absorption and decrease swelling (Navarro 1998: 38; Clarke 1997: 202; Weinstein 1997: 527).

Depending on agency protocol, a cooling or heat pack must be applied to the site of extravasation (Weinstein 1997: 527). It has been argued that in the case of most antineoplastic extravasations, ice or a cold compress should be applied 15 to 30 minutes four times a day, with the exception of the vinca alkaloids, where heat application is recommended (Navarro 1998: 38; Weinstein 1997: 525, 526). The rationale for using ice or a cold compress is that it decreases blood supply and drug absorption into subcutaneous tissues, and constricts peripheral veins, thus resulting in a decreased blood supply to the affected area (Weinstein 1997: 526). This helps minimise localised pain; decreases the destructive effect of white cell components; and improves the survival of marginally injured tissues due to the slowing of cellular metabolic rates (Weinstein 1997: 526).

Conversely, the rationale for using heat is to promote healing after the first 24 hours by increasing blood supply to the affected area and to enhance absorption of the vesicant agent (Weinstein 1997: 526; Springhouse Corporation 1993: 136). Opponents, however, feel that heat increases metabolic demands and therefore may decrease cellular destruction of vesicant agents (Weinstein 1997: 526).

To minimise surface inflammatory and erythematous reactions topical antidotes must be applied (Weinstein 1997: 527). In addition, if there is evidence of partial thickness or full thickness skin loss it requires further treatment guided by current evidence-based theories of moist wound healing, which involves protecting the wound with a sterile dressing, providing a moist environment, and using a topical antibacterial cream to keep the affected area potentially free of infection (Pettit and Hughes 1993: 75). Products that are effective in treating extravasation-related tissue injuries include transparent dressings such as Tegaderm and Op-Site, and hydrocolloid wafer dressings such as DuoDerm (Pettit and Hughes 1993: 76). Another alternative is Vigilon, a gel-type sheet dressing which, unlike the previously mentioned products, provides a moist environment requiring adhesion to the skin (Pettit and Hughes 1993: 76).

It is integral to document the circumstances surrounding the extravasation incident, in addition to photographing the site if possible, to help follow the course of injury and evaluate the effectiveness of treatment (Pettit and Hughes 1993: 76; Wood and Gullo 1993: 43). It is also important to recognise that if another IV is required a site well above the site of extravasation must be selected, as a slow leak may occur if it is started below the site (Bohony 1993: 45, 46). Pettit and Hughes argue that if possible the same vein should not be used for subsequent cannulation as injury to a vein following extravasation is often difficult to assess (1993: 77).

While it is important that nurses are able to provide prompt and effective treatment when an extravasation occurs, it is vital that they are knowledgeable with regard to the ways in which to help prevent it. In addition, they must be aware of those who have a greater risk of intravenous extravasation. Those at risk include the elderly, as their veins have lost much of their elasticity and as such they are less likely to close around an intravenous catheter effectively, allowing fluid to seep around the cannula and into the surrounding tissues (Bohony 1993: 45). Infants, unconscious patients, those receiving infusions via an infusion pump or push, and those requiring resuscitation are at greatest risk for extravasation injury (Brown et al 1979; Burd et al 1985 both cited in Pettit and Hughes 1993: 70). Cancer patients are also at risk, as they often have veins that are fragile, small, or sclerosed from prolonged chemotherapy treatments, and as such extravasation may be inevitable in such high-risk patients (Wood and Gullo 1993: 42). Those with IVs placed near joints and in deep veins are also at risk (Bohony 1993: 45). The use of rigid steel cannulas also significantly increase the risk and incidence of extravasation when compared with a plastic or Teflon catheter (Fuller 1999: 233; Bohony 1993: 45; Springhouse Corporation 1993:132).

To help minimize the risk of extravasation, it is important when selecting a site for peripheral IV cannulation that areas difficult to immobilize should be avoided, particularly those near areas of flexion such as the antecubital fossa; or surrounding tendons, nerves, or arteries (Pettit and Hughes 1993: 76); or areas of inflammation or infection (Jackson 1997: 22). Suitable veins include those on the dorsum of the hand, and the cephalic and basilic veins of the forearm (Jackson 1997: 22). It is important that existing IV sites are not reused as vascular integrity diminishes over time (Wood and Gullo 1993: 44). Furthermore, multiple venipunctures encourage extravasation if the vein used to administer the drug is distal to the previous site (Wood and Gullo 1993: 44). If a venipuncture is unsuccessful, a different vein in the opposite arm should be chosen. If, however, this is not possible, an insertion site in the same vein that is proximal to the previous one should be selected to prevent extravasation from the upstream venipuncture (Wood and Gullo 1993: 44).

Another way in which to help prevent extravasation that is also an integral part of IV care, is maintaining patency of the cannula (Dougherty 1997: 41). During regular use, the patency of the device must be determined with flushing (Dougherty 1997: 41; LaRocca 1994:114). Studies comparing the use of sodium chloride 0.9% for injection with heparin solution as a flush solution for peripheral IV lines in adults conclude that heparin sodium is no more effective than normal saline 0.9% for maintaining catheter patency (Peterson and Kirchoff 1991; Goode et al 1991; Hamilton et al 1988; Epperson 1984 all cited in Fuller 1998: 677). Normal saline 0.9% can also reduce drug incompatibilities and does not cause the side-effects associated with heparin (Fuller 1998: 677; Dougherty 1997: 42). It appears that the recommendation is to eliminate heparin flushes in peripheral cannulae (Good et al 1991 cited in Dougherty 1997: 42). Weinstein asserts that the cannula should be flushed with 3 to 5mL of normal saline between each drug infused, and 8 to 10mL upon completion of infusion of a drug or drugs (1997: 521). With regard to central venous

catheters, the small number of controlled studies related to maintaining patency in such devices means that it is not possible to make similar recommendations and as such the use of normal saline to flush CVCs is unusual and controversial (Clarke and Cox 1988; Kelly et al 1992; Leighton 1994; Baranowski 1993 all cited in Dougherty 1997: 42).

To prevent cannula dislodgement and allow for easy visual inspection of the insertion site a clear, occlusive dressing should be used (Fuller 1999: 234; Bohony 1993: 45; Pettit and Hughes 1993: 77; Wood and Gullo 1993: 45). To help reduce venospasm a glyceryl trinitrate patch may be applied proximal to the cannula site as it produces venodilation (Clarke 1997: 202). When the dressing is changed and/or before administration of medication, it is important that a thorough assessment of the IV site must be performed (Dougherty 1997: 41). While hourly assessment with accompanying documentation of the IV site is sufficient for most patients receiving an IV infusion, observations should be more frequent for those receiving irritant and vesicant medications or solutions as they carry a high risk of causing tissue necrosis (Clarke 1997: 202; Pettit and Hughes 1993: 77).

Vesicant agents are commonly administered using the two-syringe technique or through the side port of a free-flowing peripheral IV line (Weinstein 1997: 520). The two-syringe method allows for proper assessment of blood return and resistance in the vein (Weinstein 1997: 520; Wood and Gullo 1993: 45). Conversely, the side-port method increases the time the vein is exposed to the vesicant, but reduces its concentration and pressure on the vein (Wood and Gullo 1997: 45). It has been argued that nurses prefer the side-port method for administering vesicants as it decreases the probability of cannula movement (Wood and Gullo 1993: 45).

With regard to the sequencing of vesicant drug administration, Weinstein argues that it is unimportant (1997: 521). Wood and Gullo claim that the sequencing of chemotherapy--related drugs is controversial as some nurses administer the vesicant between two nonvesicants; while others always administer the vesicant last (1993: 43). Some evidence indicated that a patient is less sedated from an antiemetic and better able to report symptoms when the vesicant is administered first (Weinstein 1997: 521; Wood and Gullo 1993: 45). A vesicant may also be less likely to leak through a damaged vein if administered first, as vascular integrity declines through the course of successive cytotoxic injections (Weinstein 1997: 521; Otto (ed) 1990 cited in Wood and Gullo 1993: 46). Conversely, some clinicians believe that when a vesicant is administered after a nonvesicant its irritating effects may be minimized (Wood and Gullo 1993: 46). It is also assumed that because a vein tolerated a nonvesicant it will also tolerate a vesicant (Navarro 1998: 38; Weinstein 1997: 521).

For those who have small, fragile veins and are in need of long-term indefinite chemotherapy, continuous infusion of vesicant drugs, or both, a vascular access device such as an implanted port, tunneled catheter, or a nontunneled central venous catheter may be indicated as they decrease the risk of extravasation (Weinstein 1997: 522; Wood and Gullo 1993: 44); and because a vesicant should never be administered as a continuous infusion into a peripheral vein (Weinstein 1997: 519). Central venous delivery has become essential as a result of an increased awareness of the complications associated with the use of vesicant, sclerosant, antiviral, and phlebogenic agents (Todd 1998: 297).

Todd claims that a peripherally inserted central catheter is the preferred device in many situations to other central venous access devices as it is associated with far fewer complications (1998: 297). For

instance, it reduces a patient's exposure to multiple repeated venipunctures and associated trauma as the insertion involves one cannulation only, and as such it preserves their peripheral veins for future vascular access (MacRae 1998: 99; Todd 1998: 299). It is inserted under local anaesthesia using a topical anaesthetic cream over the skin in the antecubital fossa, via a peripheral vein, usually the cephalic or basilic, and is threaded through the axillary vein into the lower third of the superior vena cava (Todd 1998: 299, 300). It is indicated for use in the administration of vesicant chemotherapy, phlebotogenic drugs, intravenous hydration, total parenteral nutrition, and continuous narcotic infusions (MacRae 1998: 99; Todd 1998: 299).

It is clear that IV extravasation is a serious complication associated with intravenous therapy. An important nursing skill is the ability to assess and recognise the signs and symptoms associated with extravasation early with routine inspection of the IV site. While the care of the intravenous device is the responsibility of both the nurse and patient, the key to decreasing extravasation injury is nursing's awareness of potential hazards of intravenous therapy (Pettit and Hughes 1993: 77). Nurses mustn't become complacent about the risks involved in intravenous access of any kind as they expand their practice into more sophisticated realms (Rogers 1997: 546). Clearly the emphasis should be on perfecting intravenous technique and safety in conjunction with the use of prudent preparation measures in case an extravasation should occur (Fuller 1998: 675; Weinstein 1997: 518). To improve care and reduce the risks of complications of intravenous therapy such as extravasation it is important that nurses make informed decisions in practice through reading about new developments and improvements in the research literature.

References

- Bohony, J. 1993, '9 Common IV Complications and What to do About Them', *American Journal of Nursing*, October, pp45-49.
- Clarke, A. 1997, 'The nursing management of intravenous drug therapy' *British Journal of Nursing*, 6 (4), pp201-206.
- Del Guido, D and Mennona-Quinn, D. 1998, 'Chemotherapy. Potential Occupational Hazards' *American Journal of Nursing*, 98 (11), ppS9-65.
- Dougherty, L. 1997, 'Reducing the risk of complication in IV therapy' *Nursing Standard*, 12 (5), pp40-42.
- Fuller, A. 1999, 'Selecting equipment for peripheral intravenous cannulation' *Professional Nurse*, 14 (4), pp233-236.
- Fuller, A. 1998, 'The management of peripheral IV lines' *Professional Nurse*, 13 (10), pp675-678.
- Jackson, A. 1997, 'Performing peripheral intravenous cannulation' *Professional Nurse*, 13 (1), pp21-25.
- LaRocca, JC. 1994, *Handbook of Home Care IV Therapy*. Mosby-Year Book Inc, Missoun.
- MacRae, K. 1998, 'Hand-held Dopplers in central catheter insertion' *Professional Nurse*, 14 (2), pp99-102.
- Navarro, TM. 1998, 'Chemotherapy Extravasation' *American Journal of Nursing*, 98 (11), p38.
- Pettit, J and Hughes, K. 1993, 'Intravenous extravasation: Mechanisms, management, and prevention' *Journal of Perinatal and Neonatal Nursing*, 6 (3), pp69-79.
- Rogers, R (ed) 1997, 'The principles of IV therapy' *Professional Nurse*, 12 (8), p546.
- Springhouse Corporation. 1993, *Medication Administration & IV Therapy Manual*. Second Edition. Springhouse Corporation, Pennsylvania.
- Weinstein, SM. 1997, *Plumer's Principles & Practice of Intravenous Therapy*. Sixth Edition. Lippincott, Pennsylvania.
- Wood, LS and Gullo, SM. 1993, 'IV Vesicants: How to Avoid Extravasation' *American Journal of Nursing*, April, pp42-46.